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ABSTRACT

This report describes a computer-monitoring study of users of the Ohio State University Libraries' online catalog, an established and heavily used information retrieval system. Designed for end users, online library catalogs require little or no formal training, and often replace an existing manual system. Data were gathered unobtrusively by monitoring all transactions from 45 terminals on 5 of the Ohio State University campus libraries. The terminals were monitored online for 3 weeks in each of the winter, spring, and autumn terms and 2 weeks of the summer term 1981, and observation data were used to define user sessions. The study characterizes user behavior in terms of types of searches done, patterns of use, time spent on searching, errors, and system problems. Preliminary results suggest that users have much shorter sessions on online-catalog systems than on other types of retrieval systems. Patterns of use vary between campus libraries, academic quarters, and between short and long sessions. Results of the study will be applied to improving the user interface and other system features. (Author/THC)

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Date: 1983 August 31

Research Report Prepared for OCLC

on

END USER BEHAVIOR ON THE OHIO STATE UNIVERSITY LIBRARIES' ONLINE CATALOG: A COMPUTER MONITORING STUDY

by

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We must thank the staff and administration of The Ohio State University Libraries for their continued cooperation throughout the study. Susan Logan of the OSU Library Automation Office provided extensive technical assistance to the project.

Also, my special thanks to the OCLC staff members who assisted in the data analysis. The Markov process analysis and graph analysis programs were written by Howard Turtle under the guidance of W. David Penniman and modified for the LCS dataset by Mark Ackerman and Trong Do.

ABSTRACT

This report describes a computer-monitoring study of users of The Ohio State University Libraries' online catalog, an established and heavily used information retrieval system. To our knowledge, this is the first monitoring study of an online catalog performed without system-defined user sessions. Online catalogs represent a class of retrieval systems which are designed for end users, require little or no formal training, and replace an existing manual system. The study characterizes user behavior in terms of types of searches done, patterns of use, time spent on searching, errors, and system problems. Preliminary results suggest that users have much shorter sessions on online-catalog systems than on other types of retrieval systems. Patterns of use vary between campus libraries, academic quarters, and between short and long sessions. Results of the study will be applied to improving the user interface and other system features.

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1.0 INTRODUCTION

Information retrieval systems began as a technological innovation which provided an alternative means of access to vast amounts of data. These highly specialized systems required extensive training to use and were usually operated by trained search intermediaries, rather than by the end users who needed the information.

We are now seeing a major shift in user population. Information retrieval systems are rapidly cultivating an end user market in a variety of domains. Time-sharing systems serving home computer users, such as CompuServe and The Source, have been offering limited information retrieval services to their customers for several years. Videotex services accessible through home television sets (occasionally as part of a cable service) offer retrieval from news, shopping, and other consumer-oriented databases. Two of the major bibliographic retrieval services, DIALOG and BRS, have recently announced low-cost evening rates for database access with a simplified command language. This service is also aimed at the personal-computer owner.

Libraries have been major users and suppliers of information retrieval systems for many years, both in the technical and public service areas. Libraries have recently joined the end user market by replacing their card catalogs with online catalogs.

We have chosen to study information retrieval behavior in the domain of online catalogs both in service to our library audience and because online catalogs are a rich test bed for behavioral research in human-computer interaction. They offer us an opportunity to study the behavior of people who are motivated to seek the information provided by the system, but who may not be motivated to use the technology itself. The circumstances of online catalog use are such that no formal training can be required, and only minimal training can be offered, such as a brief pamphlet, a computer-assisted-instruction program, information displays, and reference manuals. Any study of user behavior on a system which requires no training is inherently a study of the user interface and its ability to convey information.

As libraries began to implement online catalogs, and many more libraries were faced with the decision to adopt these catalogs, the need for more information about online catalog use became apparent. To fill this need, the Council on Library Resources funded a nationwide study of online catalogs in public, academic, and college libraries (Ferguson et al. 1982; Kaske and Sanders 1983; Markey 1983; Tolle 1983). The study, known as the Online Public Access Catalog Evaluation Project, examined 17 online catalog installations at 29 institutions in the United States, using multiple research methods.

Online catalog users and nonusers were surveyed for their attitudes about the systems, library staff were interviewed, online-monitoring studies were performed and the software features were analyzed (Borgman 1982; Tolle 1983; Hildreth 1982).

This report describes the online-monitoring study of one online catalog, The Ohio State University Library Control System (LCS). We chose to study the Library Control System first and in the most depth for several reasons. First, LCS, being one of the oldest and most heavily used systems currently available, allowed us to study a stable system with a large population of regular users. Second, the system was regularly monitored as part of the maintenance process, providing a very large sample of users, across multiple campus libraries, and over a one-year period. Third, we were able to corroborate the monitoring data with observation data from another study, the NSF-sponsored "Terminal Requirements for Online Catalogs in Libraries," allowing us to parse the data into individual user sessions. These three factors combined to allow us to create a much richer dataset than we could obtain from other online catalog systems.

2.0 RELATED RESEARCH

The online-monitoring methodology has been applied to user behavior on several other information retrieval systems, but to our knowledge, this study and that of Tolle are the first applications of the methodology to online catalogs (Tolle 1983). Penniman and Dominick (1980) provide a thorough review of information retrieval-monitoring studies through 1980. While they do not explicitly list results for these studies, they, and others, do outline some of the variables which were studied: interactions per session, interactions per minute (Penniman and Perry 1976); query complexity (Mittman and Dominick 1973); probability of session length in minutes for different database types (Penniman and Perry 1976); learning curve for terminal users (Kennedy 1975); and most likely paths of next actions in a search session (Penniman 1975a, 1975b).

In his dissertation (1975), Penniman described users of the BASIS System in terms of a Markov model and found that the data supported the model. In a more recent study (1981), Penniman compared patterns of use for infrequent, moderate, and frequent users of the MEDLINE System. He found significant differences among groups in frequency of individual commands. Several of the more advanced features of the system were used almost exclusively by the frequent users. Infrequent users were slower, while experienced searchers use more commands and more connect time than inexperienced searchers.

The MEDLINE System has 50 user commands, representing 16 "states" or phases of the search, such as logon, term selection, strategy formation, reviewing results, and so on. Penniman found that an average session contained 47.5 transactions and lasted 9 minutes and 45 seconds, for an average of 4.8 transactions per minute. Penniman also found that users had difficulty logging onto the system; 69% of the unique ID numbers were spurious and generated by users attempting to logon with a mistyped or incorrect ID number. We will compare these results to the LCS data.

Another use of monitoring data is to corroborate survey data about system use. Considerable differences may be found between the way in which users say they use a system and the evidence provided by a log of their transactions. In a public-funded videotex evaluation, the University of Kentucky/USDA Green Thumb System provided system data which correlated less than 30% with reported usage figures while showing a clear downward trend over the 13 months recorded (Warner and Clearfield 1981; Rice and Paisley 1982). USDA policy and marketing implications based upon system-monitored system data ran counter to some of the implications based upon respondents' reports of their usage.

3.0 RESEARCH QUESTIONS

The purpose of this study was to examine the behavior of system users by unobtrusive measures through the use of monitoring data. The computer-monitoring methodology was chosen as it provides a complete and accurate record of online behavior. Computer monitoring of an online system is simply logging (automatically) every transaction made from a terminal and the time when it occurred (Rice and Borgman 1983; Borgman and Rice 1982; Penniman and Dominick 1980). We captured both transactional data (what happened and at what terminal) and temporal data (when did it happen). For the purposes of our analysis, we define "transaction" as any set of keystrokes followed by a "carriage return" or "enter," and "session" as a sequence of transactions bounded by a user start and end time.

The Library Control System, like many other online catalogs, differs from most types of information retrieval systems in that users do not have to logon or logoff. They simply walk up to a dedicated LCS terminal and begin entering LCS commands. Users neither issue a specific "start of session" command nor identify themselves to the system. While this feature makes the system easier to use and guarantees anonymity, it creates a problem for the researcher who wishes to delineate the transactions belonging to individual users. To our knowledge, we are the first to attempt an online-monitoring study of user behavior where user sessions were defined with data external to the system.

We collected observational data to establish the session delimiters. The advantage of session data over raw transactions is that we can study the behavior of individual users, rather than just an aggregate of system use. Such data allow us to study the types of searches people perform, what difficulties they have with the system, and how much time they spend with it.

Given these considerations, we chose to explore the following research questions with these data.

1. How long do people spend at a terminal in a session?
   a) when measured in elapsed time?
   b) when measured in number of transactions?

2. How does session length vary (in time and in transactions)?
   a) by campus library?
   b) by academic quarter?
   c) by terminal type (sitting or standing)?

3. How are commands distributed?
   a) by campus library?
   b) by academic quarter?

4. How does behavior vary by session?
   a) What is the composition of search types (author, title, subject, etc.) within a session?
      i) by campus library?
      ii) by academic quarter?
   b) What proportion of all sessions contains any subject searching?
      i) by campus library?
      ii) by academic quarter?
   c) What proportion of all sessions consists entirely of errors?
      i) by campus library?
      ii) by academic quarter?

5. How does behavior vary by length of session?
   a) in terms of command distribution?
   b) in terms of the proportion of subject searching?
   c) in terms of all-error sessions?

The data are rich enough to support many further investigations, but we will limit our discussion to these research questions for this summary report.

4.0 METHODOLOGY

We combined two methodologies for data collection in this study: online monitoring of selected terminals and observation of users to determine when they began search sessions. We gathered data unobtrusively by monitoring all transactions from a total of 45 terminals in five of The Ohio State University campus libraries. The terminals were monitored for three weeks in each of the winter, spring, and autumn terms and two weeks of the summer term 1981.

We utilized observation data which were being collected for an NSF-sponsored queuing study of the same terminals (Tolle 1982). The use of the observation data provided us with a rich dataset at no additional collection cost over gathering the monitoring data.

During the NSF study, observers were posted in all terminal areas for two-hour time blocks at peak periods of the day during the data collection periods. The terminals were monitored during the same periods. Each time a different person approached a terminal, the observer noted the exact arrival time and the terminal identification number. The observers were performing a queuing study requiring only arrival time data, and they did not record the time the person left the terminal.

The observer data were keyed to tape, and we then attempted to match the observer times with the transaction times on the monitoring tapes, resulting in data parsed into user sessions. The matching process turned out to be an extremely difficult task--one to which we devoted nearly a year of effort. We quickly realized that much more is involved than merely matching two sets of time stamps. We found that we had to account for several additional variables. These variables included 1) the drift of both the computer time clock and the observers' watches (though synchrony had been attempted); 2) any elapsed time between the observation of the user at the terminal and entry of the first carriage return; and 3) missing observations of users (for whom we had transactions) or incorrectly recorded observations of users (for whom we had an observation time, but no transactions). After extensive analysis, we designed an algorithm which was able to match 61.5% of the user transactions with sessions.

To test if the parsing was accurate, we compared the command distribution over all the data (prior to parsing) for the month of May 1981 with the command distribution for the parsed data for spring term 1981 (including May) and found that the command distributions were not significantly different ($p > 0.05$) by a chi-square test. We concluded that the parsed data were an accurate sample of the larger dataset on this gross measure, and we proceeded with the data analysis.

We reduced the overall dataset in several steps before obtaining the final dataset for analysis. We began with the set of all 66,543 transactions

(during 6,045 user sessions) from all LCS terminals during the 11 weeks of data collection. From this dataset, we extracted the transactions for the public terminals (excluding those in staff areas) in the five campus libraries for which we had observation data. This dataset was further reduced to only those hours during which observers were present. We sorted the data into individual datasets for each terminal and each academic quarter, resulting in 170 datasets. We had observed a total of 45 terminals over four academic quarters, but no summer term observation was done at 10 of the terminals.

Of the 170 datasets, we selected 118, which we knew had few, if any, observational problems, and matched these against the appropriate observation data to match them into sessions. We were able to parse 61.5% of the transactions in the 118 datasets into unique user sessions.

We systematically selected 15 of the 45 terminals for final data analysis, representing all libraries and all academic quarters, balancing sitting and standing terminals and traffic locations in each library. No summer data collection was performed at two of the libraries, resulting in a loss of four of the 60 possible datasets. All of the analysis reported here is based on the remaining 56 datasets.

The data used in the analysis in this report are summarized in table 1.

TABLE 1

Data Used for Analysis

Library	Number of Quarters	Number of Terminals	Number of Transactions	Number of Sessions
Main				
Info. Desk area	4	5	9,815	610
Card Catalog area	4	2	16,265	1,391
Education	4	2	9,595	1,035
Engineering	3	2	11,366	1,190
Undergraduate	4	2	10,136	882
West Campus	3	2	9,366	937
Total		15	66,543	6,045

Quarter	Number of Libraries	Number of Terminals	Number of Transactions	Number of Sessions
Autumn	5	15	21,795	2,029
Winter	5	15	21,108	1,911
Spring	5	15	19,480	1,743
Summer	3	11	4,160	364
Total			66,543	6,045

The data elements collected are summarized in table 2.

TABLE 2

LCS Data Elements

Data Collected

- Online
  1. Terminal identification number
  2. Commands
  3. Search key
  4. Time of command (to the second)
  5. Date of transaction
  6. Computer response (match, no match, error)

- Offline
  1. Terminal identification number
  2. Session start time
  3. Male/female
  4. Staff/patron

Collected, Not Used

- Online
  1. Text of search key

- Offline
  1. Male/female
  2. Staff/patron

Not Collected

1. Number of matches
2. Patron identification
3. Session end time

In order to analyze the temporal data, we noted the time at which each transaction occurred and the computed elapsed time between transactions, or "gap time." The gap time was defined as the amount of time spent in a "command state." For example, if a user typed in a title command, 45 seconds later typed in a page number command, and 30 seconds after that typed in a line number command, that user spent 45 seconds in the "title command state" reviewing the results of the title search, followed by 30 seconds in the "page command state"; the gap times were 45 seconds and 30 seconds, respectively.

We used the session delimiters and gap times to compute two measures of session length. Session length in number of transactions is simply a count of all transactions in a session. Session length in elapsed time is the total of all the gap times from the first through the last transaction. Note that the latter computation does not include a gap time for the last transaction of the session; we do not know the elapsed time from the last carriage return to the time the user left the terminal. Therefore, the measure of session length in elapsed time slightly underestimates the true value.

Data analysis was performed using the Statistical Analysis System (SAS) and custom-designed stochastic process and graph analysis programs.

5.0 LCS STRUCTURE

The Library Control System (LCS) became operational as a combined catalog and circulation system in 1970; public access terminals were first installed in 1975. In 1978, the online catalog capability was added and now provides full-record access to materials acquired after 1973. As of 1982, 115 dedicated LCS public access terminals were available throughout the OSU library system, and nearly 14 million transactions were performed on the system in the 1981/82 academic year. LCS serves a population of 57,000 students, 18,000 faculty and staff, plus an unknown number of library visitors. While the card catalog is still available, it is no longer kept current. For additional information on the development of LCS, refer to the reports of Norden and Lawrence (1981) and Miller (1979).

LCS is actually both an online catalog and a circulation system. Terminals located on library circulation desks and in library staff offices have capabilities to check materials in and out and to search patron files, in addition to online catalog access. Terminals in public areas have online catalog access only. Most of the terminals are of the video display tube (VDT) variety; a few printing terminals are available throughout the library system. Some dial-up access is offered as well.

We collected data only from VDT terminals in the library. Since our objective was to capture patron (rather than library staff) behavior, we selected for analysis terminals that received heavier patron than staff usage, and we instructed the observers not to record any staff use of the terminals. As noted above, such gaps in the collected data complicated the process of matching transaction tapes with observer records. This procedure would likely be changed in any future monitoring effort.

The Library Control System is a command-driven system which allows searching by author, title, author/title combination, subject heading, and call number. No Boolean combinations of these access points are possible, however. To search, one types in a three-character command to indicate the type of search (e.g., AUT for author), followed by a slash and a search key containing a specified number of characters describing the item or topic sought (the number of characters in the search key varies by search type). The system response varies by command, returning a list of one-line entries matching the search key in most cases. The number of steps required to complete a search varies by search type as well. The display of a single record includes the bibliographic description (standard information found on a catalog card), the call number, owning libraries, and the circulation status of each copy (currently checked in, or, if out, when due). The complete list of searching commands and their structures is outlined in table 3.

TABLE 3

Library Control System Taxonomy

A. LCS search commands can be divided into three types based on the number of steps required to arrive at the display of a bibliographic and circulation record. Each step has a unique paging command associated with it.
   a. 3-step command: SIS
   b. 2-step commands: AUT, ATS, TLS, SPS
   c. 1-step commands: FBC, DSC

B. Search commands and associated paging commands (user-originated commands that allow him/her to page or browse through the material retrieved).

STEP	COMMAND						
1.	SIS	AUT	ATS	TLS	SPS	FBC	DSC
1a.	PS	PG	PG	PG	PG	PD	PD
2.	SBL	DSL/FBL	DSL/FBL	DSL/FBL	DSL/FBL		
2a.	PG	PD	PD	PD	PD		
3.	DSL/FBL						
3a.	PD						

C. Purpose and Result of Each Command

COMMAND	PURPOSE OF COMMAND (P) AND RESULTING DISPLAY (R)
3-STEP COMMAND: SIS	
1. SIS	P: Search by subject R: List of subject headings
1a. PS	P: Browse through list of subject headings R: Next or previous page of subject headings
2. SBL	P: Select a subject heading by line number R: List of records matching subject heading selected
2a. PG	P: Browse through list of titles R: Next or previous page of titles
3. DSL	P: Select a specific title by line number R: Display of short bibliographic record matching line number
3. FBL	P: Select a specific title by line number; restricted to items with a "full bibliographic record" in file R: Display of full bibliographic record matching line number
3a. PD	P: Page through a bibliographic record, short or full, which requires more than one screen R: Next or previous page of bibliographic record, short or full

TABLE 3--Continued

COMMAND	PURPOSE OF COMMAND (P) AND RESULTING DISPLAY (R)
2-STEP COMMANDS: AUT, ATS, TLS, SPS	
1. AUT	P: Search by author name R: List of records matching author name
1. ATS	P: Search by author and title combination R: List of records matching author/title combination
1. TLS	P: Search by title R: List of records matching title
1. SPS	P: Search by general call number (not restricted by Cutter number) R: List of records matching call number
1a. PG	P: Browse through list of titles R: Next or previous page of titles
2. DSL	P: Select a specific title by line number R: Display of short bibliographic record matching line number
2. FBL	P: Select a specific title by line number; restricted to items with a "full bibliographic record" in file R: Display of full bibliographic record matching line number
2a. PD	P: Page through a bibliographic record, short or full, which requires more than one screen R: Next or previous page of bibliographic record, short or full
1-STEP COMMANDS: FBC, DSC	
1. DSC	P: Search by exact call number to locate a specific title R: Display of short bibliographic record matching call number
1. FBC	P: Search by exact call number to locate a specific title for an item which has a "full bibliographic record" in the file R: Display of full bibliographic record matching call number
1a. PD	P: Page through a bibliographic record, short or full, which requires more than one screen R: Next or previous page of bibliographic record, short or full

6.0 RESULTS

Results of the analyses performed are presented individually and are discussed further in the discussion section.

6.1 Session Length

We examined session length, both in terms of number of transactions and in elapsed time. As described above, session length in number of transactions is simply a count of commands given by the user during a session; session length in elapsed time is measured from the first through the last carriage return, and, because the elapsed time from the last carriage return to the moment when the user leaves the terminal is unknown, this measure slightly underestimates session time.

Session length, both in number of transactions and in elapsed time, was found to be highly skewed to the left. Most sessions were very short, but a few were very long. All the session length distributions, by library, by quarter, and by individual terminal, were different from a normal distribution ($p < 0.01$) by a Kolmogorov-Smirnov D-statistic test of normality. Due to the non-normality of the data, mode and median are used to describe most individual distributions rather than the mean and standard deviation.

6.1.1 Session Length by Library

We hypothesized that session length might vary by campus library, due to differences in their collections and their users. LCS is a union catalog for the OSU system; therefore, the search process, database, and results are the same no matter where the search is performed.

The Education and Engineering libraries are specialized collections for those departments; Undergraduate and West Campus libraries both serve a predominantly undergraduate population. The Main library contains the primary research collection for the University. Main library terminals have been divided into two groups: those in the main Information Desk area of the library (labeled Info. Desk) which has the largest cluster of terminals (24) on campus and the Card Catalog area (labeled Card Cat.), which has an additional 4 terminals. We have treated these as separate libraries throughout the study due to differences in the characteristics of use. The Education library has 7 terminals, Engineering has 4, and the Undergraduate and West Campus libraries each have 6 terminals. The session length data for these libraries are summarized in table 4.

As can be seen from table 4, the median number of transactions is stable across libraries, but the elapsed time of sessions is not.

TABLE 4

Session Length by Library

Library	No. of Transactions		Elapsed Time (Sec.)		Number of	
	Mode	Median	Mode	Median	Sessions	Transactions
	All Four Quarters					
Main--Info. Desk	2	5	18	145	610	9,815
Main--Card Cat.	1	7	101	236	1,391	16,265
Education	2	5	11	142	1,035	9,595
Engineering	2	6	18	160	1,190	11,366
Undergraduate	2	6	40	186	882	10,136
West Campus	2	6	49	235	937	9,366

6.1.2 Session Length by Academic Quarter

We hypothesized that session length might vary by academic quarter. The data are summarized in table 5.

As stated in the Methodology section, the data were collected from January to December of 1981, but are arranged by academic year as this is the usual progression of use. Autumn quarter (81/82 academic year) has the longest search time, followed by winter, spring, and summer (80/81 academic year). People appear to do the same amount of searching (in number of transactions) each quarter, but get faster in the later quarters of the academic year.

We can see that the patterns of use are much different between LCS and such information retrieval systems as MEDLINE. Penniman (1981) found that sessions averaged 47.5 transactions and 9 minutes and 45 seconds in length, far longer than LCS sessions. LCS sessions have a median of 5 to 6 transactions and a typical elapsed time of 2 to 4 minutes.

TABLE 5

Session Length by Academic Quarter

Quarter	No. of Transactions		Elapsed Time (Sec.)		Number of	
	Mode	Median	Mode	Median	Sessions	Transactions
All Libraries						
Autumn	2	6	18	189	2,029	21,795
Winter	2	6	20	182	1,911	21,108
Spring	2	6	21	168	1,743	19,480
Summer	2	5	42	143	364	4,160

6.1.3 Session Length by Terminal Type

We suspected that users might spend more time at those terminals with a chair or stool in front of them than at terminals without seating. We compared sitting and standing terminals in each library. Note that the Card Catalog area of the Main library has no sitting terminals and that West Campus library has no standing terminals. An additional category of "fast" was created for the Information Desk area to identify those terminals near the entrance to the area which appeared to have more rapid search sessions. These so-called "fast" terminals are all standing terminals. Results are summarized in table 6.

Session length is greater in all cases, both in elapsed time and in number of transactions, for sitting than for standing terminals. Session length varies considerably among libraries.

TABLE 6

Session Length, Sitting vs. Standing Terminals

	Info. Desk			Card Cat.	Education	
	Sit	Stand	Fast	Stand	Sit	Stand
TIME (Sec.)						
Median	408.5	185	149	236	172.5	121
Mode	49	45	18	101	11	45
No. of Sessions*	522	1,025	634	1,243	430	511
TRANSACTIONS						
Median	11	7	5	7	6	5
Mode	5	2	2	1	2	2
No. of Sessions*	550	1,096	696	1,387	461	575

	Engineering		West Campus	Undergraduate	
	Sit	Stand	Sit	Sit	Stand
TIME (Sec.)					
Median	213.5	135.5	235	231	106.5
Mode	18	13	49	33	95
No. of Sessions*	426	660	861	529	280
TRANSACTIONS					
Median	6	5	6	8	5
Mode	2	2	2	4	2
No. of Sessions*	458	728	935	562	319

*The number of sessions is fewer for computations by elapsed time than for computations by number of transactions, because we have no elapsed time associated with the last transaction in the session. Therefore, single-transaction sessions have no time associated with them and are not included in the computation.

6.2 Command Distribution

We wished to examine an aggregate of command usage across libraries and across quarters. (See table 3 for a description of command structure.)

Command distribution by library and by quarter is shown in tables 7 and 8. Two types of errors are defined. A "typing error" is a command unrecognized by the system, presumably some typographical error in the three-character command code. Entries in which the command was correct, but some detectable error was made in the search key, are considered "logical errors."

TABLE 7

Command Usage by Library

Command	Info. Desk	Card Cat.	Educ.	Eng.	West Campus	Under-grad.	No. of Transactions
	Percent of All Commands						
Search Commands							
AUT	7.2	6.7	6.6	4.9	3.4	4.9	3,802
TLS	10.4	7.6	12.2	10.5	5.6	8.9	6,047
ATS	4.6	2.5	4.3	2.4	8.5	5.6	2,906
SIS	8.2	13.3	7.6	10.7	11.8	9.1	6,951
Call Number							
DSC	4.3	4.3	4.9	4.5	1.8	2.5	2,529
FBC	0.1	0.4	0.3	0.1	0.3	0.1	147
SPS	0.8	0.5	0.6	0.7	0.6	2.7	641
Subtotal	(35.6)	(35.3)	(36.5)	(33.8)	(31.9)	(33.8)	(23,023)
Paging Commands							
PD	2.1	1.5	3.3	2.1	1.4	1.9	1,350
PG	14.4	11.1	14.1	14.0	10.9	13.2	8,525
PS	4.4	6.4	3.1	6.0	6.5	4.7	3,541
Subtotal	(20.9)	(19.0)	(20.5)	(22.1)	(18.8)	(19.8)	(13,416)
Line Number Commands							
DSL	22.5	18.0	24.4	20.8	22.8	24.7	14,473
FBL	1.6	1.7	1.3	1.6	1.2	1.6	1,018
SBL	7.8	10.5	6.1	9.6	8.8	8.0	5,791
Subtotal	(31.9)	(30.2)	(31.8)	(32.0)	(32.8)	(34.2)	(21,282)
Errors							
Typ Err	5.9	7.3	5.9	5.3	8.2	6.1	4,326
Log Err	5.6	8.1	5.3	6.7	8.0	5.9	4,498
Subtotal	(11.5)	(15.4)	(11.2)	(12.0)	(16.2)	(12.0)	(8,824)
Total	100.0	100.0	100.0	100.0	100.0	100.0	66,545

The proportion of commands across parts of the search is relatively stable across libraries, but there is a considerable difference among libraries (table 7). For example, far more subject searches are performed at terminals in the Card Catalog area of the Main library than in the Information Desk area of the same library. Subject searching is next highest at the two libraries with a predominantly undergraduate population--West Campus and Undergraduate libraries. West Campus, where most undergraduate students perform required searches for their introductory library use course, has about half as many call number searches and twice as many author/title searches as the rest of the libraries; the number of errors is also highest at West Campus.

Use of commands is stable over the autumn, winter, and spring terms, but it shifts in the summer, particularly in the distribution of searching commands (table 8).

TABLE 8

Command Usage by Quarter

Command	Percent of Commands				Number of Transactions
	Autumn	Winter	Spring	Summer	
Search Commands					
AUT	4.8	5.6	6.0	9.2	3,802
TLS	8.5	9.0	9.1	12.5	6,047
ATS	6.7	3.4	3.1	3.3	2,906
SIS	10.1	11.1	11.0	6.4	6,951
Call Number					
DSC	3.0	4.6	3.9	3.9	2,529
FBC	0.1	0.3	0.4	0.2	147
SPS	0.9	0.5	1.7	0.3	641
Subtotal	(34.1)	(34.5)	(35.2)	(35.8)	(23,023)
Paging Commands					
PD	1.9	2.2	1.9	2.3	1,350
PG	14.3	12.3	10.8	17.1	8,525
PS	5.7	5.7	4.7	4.2	3,541
Subtotal	(21.9)	(20.2)	(17.4)	(23.7)	(13,416)
Line Number Commands					
DSL	22.0	20.6	22.3	23.9	14,473
FBL	1.6	1.4	1.6	1.0	1,018
SBL	9.1	8.5	9.1	5.8	5,791
Subtotal	(32.7)	(30.5)	(33.0)	(30.7)	(21,282)
Errors					
Typ Error	6.1	6.7	7.0	5.4	4,326
Log Error	5.2	8.1	7.6	4.3	4,498
Subtotal	(11.3)	(14.8)	(14.6)	(9.7)	(8,824)
Total	100.0	100.0	100.0	100.0	66,545

6.3 Analysis by Session

The partition of transaction data into sessions allows us to look at the behavior of individual users in searching the database. We were particularly interested in whether users tend to perform only one type of search in a session (and if so, which type) or multiple search types in a session. Also of interest is the proportion of sessions in which any subject searching

occurs. Such data have an important impact on design and training, and the information has not been available from other types of catalog use studies. These data and data on error rates are summarized in the following sections.

6.3.1 Session Search Types by Library

In table 9, we summarize the distribution of searches within sessions. Search types are listed by search command (see table 3 for a description of the commands). An "AUT" session, for example, contains only author searches (paging and display commands and errors were ignored in the computation). A "MIXED" session contains more than one type of search, and a "NONE" session contains no search commands (these are probably error-laden sessions).

Note that about one-third of all sessions contain multiple types of searches. The distribution of session search types varies considerably among libraries. The proportion of mixed sessions, for example, is much higher in both areas of the Main library than in the departmental libraries.

TABLE 9

Session Search Types by Library

Command	Info. Desk Sessions		Card Cat. Sessions		Education Sessions	
	No. of	% of	No. of	% of	No. of	% of
AUT	78	12.8	144	10.3	95	9.2
ATS	21	3.4	55	3.9	63	6.1
TLS	99	16.2	175	12.6	279	26.9
SIS	115	18.8	316	22.7	123	11.9
SPS	1	0.2	9	0.6	6	0.6
DSC	17	2.8	73	5.2	90	8.9
FBC	0	0.0	4	0.3	0	0.0
MIXED	250	40.9	526	37.8	351	33.9
NONE	30	4.9	91	6.5	29	2.8
Total	611	100.0	1,393	100.0	1,036	100.0

	Engineering Sessions		Undergraduate Sessions		West Campus Sessions		Total Sessions	
	No. of	% of	No. of	% of	No. of	% of	No. of	% of
AUT	74	6.2	63	7.1	36	3.8	490	8.1
ATS	56	4.7	92	10.4	295	31.4	582	9.6
TLS	311	26.1	149	16.9	89	9.5	1,102	18.2
SIS	224	18.8	173	19.6	191	20.4	1,142	18.9
SPS	12	1.0	5	0.6	5	0.5	38	0.6
DSC	84	7.0	56	6.3	14	1.5	334	5.5
FBC	0	0.0	0	0.0	0	0.0	4	0.0
MIXED	368	30.9	315	35.7	260	27.7	2,070	34.2
NONE	62	5.2	30	3.4	48	5.1	290	4.8
Total	1,191	100.0	883	100.0	938	100.0	6,052	100.0

6.3.2 Session Search Types by Quarter

In table 10, we present the analyses of session search types by quarter.

TABLE 10

Session Search Types by Quarter

Command	Autumn Sessions		Winter Sessions		Spring Sessions		Summer Sessions	
	No. of	% of	No. of	% of	No. of	% of	No. of	% of
AUT	114	5.6	158	8.3	175	10.0	43	11.8
ATS	342	16.8	130	6.8	90	5.2	20	5.5
TLS	305	15.0	375	19.6	358	20.5	62	17.0
SIS	377	18.6	370	19.3	347	19.9	48	13.2
SPS	18	0.9	9	0.5	11	0.6	0	0.0
DSC	85	4.2	139	7.3	79	4.5	31	8.5
FBC	1	0.0	2	0.1	1	0.0	0	0.0
MIXED	695	34.2	640	33.4	593	34.0	142	38.9
NONE	93	4.6	90	4.7	90	5.2	19	5.2
Total	2,030	100.0	1,913	100.0	1,744	100.0	365	100.0

The distribution of session search types is more stable when viewed by quarter than when viewed by library. As in other measures (see tables 5 and 8), summer quarter data are least like that of other quarters. During the summer quarter the composition of the student body is very different from the other three quarters. There is a much lower percentage of undergraduate students and a higher percentage of graduate students and continuing education students. Thus, the search patterns of graduate students, faculty, and library employees using public terminals have more of an impact on LCS searching patterns during the summer quarter than during the other three quarters. The summer term dataset also is a much smaller one than for other quarters. Campus enrollment is lower in the summer term; no data were collected in the Engineering or West Campus libraries during the summer quarter (see table 1), and we collected three weeks of data during autumn, winter, and spring quarters, but only two weeks' data in the summer quarter.

6.4 Subject Searching Sessions

Librarians have long been interested in the proportion of catalog searching for known items vs. the proportion of subject searching, so that they might allocate cataloging and reference resources more accurately. While many online catalogs (including LCS) provide subject access only by standard Library of Congress Subject Heading (LCSH), effective subject access requires keyword searching in title and subject fields, cross references, and Boolean logic capabilities. These are expensive additions to a system and must be justified by demand.

Monitoring analysis allows us to determine not only the proportion of searches which are subject requests and the proportion of sessions which are subject-only searches, but also the proportion of sessions in which any subject searching occurs. The latter measure may most accurately reflect the demand for subject searching. The data are summarized by library in table 11 and by quarter in table 12, respectively.

These data show that roughly one-third of all sessions include at least one subject search command, and that subject searching is much lower during the summer term.

TABLE 11

Sessions with Subject Commands (SIS) by Library

Percent of All Sessions					
Info. Desk	Card Cat.	Education	Engineering	Undergraduate	West Campus
36.4	41.0	21.6	32.8	35.6	35.8

TABLE 12

Sessions with Subject Commands (SIS) by Quarter

Percent of All Sessions			
Autumn	Winter	Spring	Summer
34.0	35.4	34.5	23.9

6.4.1 All-Error Sessions

In the monitoring analysis of MEDLINE, Penniman (1981) found that users are frequently unsuccessful in logging onto the system. We suspected that similar events occur in LCS, where users attempt to search, make a series of errors, and abandon the system without having any commands accepted. To test this hypothesis, we examined sessions which consisted only of errors. Tables 13 and 14 summarize the data by library and by quarter, respectively.

TABLE 13

All-Error Sessions by Library

Percent of All Sessions					
Info. Desk	Card Cat.	Education	Engineering	Undergraduate	West Campus
10.0	15.4	11.5	11.8	10.9	11.7

TABLE 14

All-Error Sessions by Quarter

Percent of All Sessions			
Autumn	Winter	Spring	Summer
11.5	13.4	11.8	12.1

6.5 Analysis of Sessions by Length

The session length distribution is highly skewed to the left, which means that most sessions are very short. We suspected that there might be a variety of different characteristics between short and long sessions, particularly in distribution of search type and in error rate.

To examine these hypotheses, we selected four terminals with similar session lengths and command distribution characteristics and combined them into one dataset. We then split the dataset into four separate datasets at three session length points (in number of transactions): mode, median, and third quartile. The four groups are "Short" (sessions with length less than or equal to the mode), "Medium" (length greater than the mode, but less than or equal to the median), "Medium-Long" (greater than the median, but less than or equal to the third quartile), and "Long" (greater than the third quartile). The datasets are described in table 15.

TABLE 15

Distribution of Session Length Data

Length	Number of Transactions	Number of Sessions
Short	324	203
Medium	917	236
Medium-Long	1,313	167
Long	5,074	210
Total	7,628	816

Each of these datasets was analyzed separately, and the results are displayed in tables 16 through 18.

These data show considerable differences among sessions of different lengths. The proportion of commands devoted to searching drops steadily (56.5% to 30.1%) from short through long sessions. The proportion of author, title, and author/title searches drops, while the proportion of subject and call number searches increases. The proportion of sessions with any subject searching increases dramatically from 12.8% to 62.4%.

The proportion of typing errors drops from short to long sessions, but the overall proportion of errors does not drop until the long sessions. Almost half (43.3%) of the short sessions (those less than or equal to the mode) consist entirely of errors, while the longer sessions are rarely all-error sessions.

We wished to compare command sequences to determine if patterns varied between short and long sessions; that is, are long sessions unique, or are they just a series of short sessions? To compare these different command sequences, we treated individual commands as states in a Markov chain. A two-sample Kolmogorov-Smirnov (KS) test was applied to determine differences in transitions between command states at the zero order (cumulative frequency), first order (one-step transitions, or two consecutive states), and second order (two-step transitions, or three consecutive states). Six KS tests were performed: short sessions vs. long and short plus medium vs. long at each of zero-, first-, and second-order transitions. All tests were significant ($p < 0.001$), suggesting that patterns of use vary greatly by session length.

TABLE 16

Command Usage by Session Length

Command	Percent of Commands				Number of Transactions
	Short	Medium	Med-Long	Long	
Search Commands					
AUT	11.4	11.7	7.5	3.9	441
TLS	20.4	14.5	13.0	6.7	711
ATS	6.5	7.1	4.6	1.9	241
SIS	8.3	7.6	9.4	13.2	892
Call Number					
DSC	9.3	5.1	5.2	3.4	316
FBC	0.0	0.1	0.0	0.0	2
SPS	0.6	1.2	1.1	1.1	81
Subtotal	(56.5)	(47.3)	(40.8)	(30.2)	(2,684)
Paging Commands					
PD	1.2	2.6	1.9	1.6	136
PG	1.5	5.1	11.8	19.2	1,182
PS	0.6	3.4	4.3	8.4	517
Subtotal	(3.3)	(11.1)	(18.0)	(29.2)	(1,835)
Line Number Commands					
DSL	23.2	23.9	20.3	18.1	1,479
FBL	0.0	0.9	1.6	1.7	116
SBL	3.4	3.8	6.2	11.1	689
Subtotal	(26.6)	(28.6)	(28.1)	(30.9)	(2,284)
Errors					
Typ Error	8.3	7.7	5.5	5.1	429
Log Error	5.3	5.2	7.8	4.5	396
Subtotal	(13.6)	(12.9)	(13.3)	(9.6)	(825)
Total	100.0	100.0	100.0	100.0	7,628

TABLE 17

All-Error Sessions by Session Length

Percent of All Sessions			
Short	Medium	Medium-Long	Long
43.3	3.8	1.8	0.0

TABLE 18

Sessions with Subject Commands by Session Length

Percent of All Sessions			
Short	Medium	Medium-Long	Long
12.8	19.5	34.7	62.4

7.0 DISCUSSION

The data presented in this report characterize the use of one online catalog system, at one major university library, at one point in time. Until comparable studies are performed on other systems, we will not know whether these data are representative of user online catalog behavior in general. However, due to vast differences between systems and library environments, we suspect that these data are not representative, except perhaps at the most general level, such as for types of searches performed.

Several interesting findings emerge from the data presented here. The most obvious are the user behavior differences among campus libraries, academic quarters, and types of terminal settings. For example, behavior is quite different between the Information Desk area and the Card Catalog area of the same library. We do not know precisely to what this difference may be attributed. The Information Desk terminals are easily accessible, while a user must make a more deliberate effort to seek out a Card Catalog area terminal. The Card Catalog area terminals also afford more privacy than the Information Desk terminals. We expected the Card Catalog area to have a high proportion of known item searches, both from people searching bibliographies and from people matching catalog cards to the system to check for availability. However, this was not the case--subject searching is higher in the Card Catalog area than for any other library!

Searching behavior in the West Campus and Undergraduate libraries, which are populated predominantly by undergraduate students, is much different from that in the other campus libraries. Undergraduates take a required course in library usage which includes LCS instruction. Most take the course during the autumn quarter, and they have to perform a required set of searches in conjunction with the course. The students are trained to use the author/title search (ATS), and this is reflected in the command distribution--31.4% of West Campus searches are ATS only. ATS use is high overall during the autumn quarter, reflecting the effect of undergraduates running required searches. We suspect that the skewed ATS use is a training effect, suggesting that we might compare it to training received by users in other libraries.

Patterns also change in command distribution and error rate across quarters. Session lengths become continuously shorter from autumn through summer terms, suggesting that users are perhaps getting faster as their expertise increases. However, this finding is contradicted by the fact that error rates increase for winter and spring terms over those of autumn, then drop off during summer term. The Ohio State University LCS user population is dynamic, and since we do not know that the same users are on the system from autumn through spring, little can be assumed in terms of transaction effects. In fact, because these data were collected in one calendar year (1981) rather than in one academic year, the autumn quarter analyzed is for the academic year following that of the winter through summer quarters. All we really know is that autumn quarter

sessions are longer than sessions in other quarters. We also know that a different population is resident during summer, and these patterns are much different.

We found that in each library sessions at sitting terminals were consistently longer than sessions at standing terminals, when measured either in number of transactions or in elapsed time. What we do not know is which direction is causal--do people, expecting to search longer or slower, seek sitting terminals, or do people just stay longer if you give them a stool? The data suggest the latter, because session length in the Card Catalog area of the Main library, which has standing terminals only, is very similar to session length for standing terminals in the Information Desk area; and session length at West Campus, which has sitting terminals only, is more similar to session length at sitting terminals in the other departmental libraries than to session length at standing terminals.

The differences between libraries, quarters, and individual terminals are sufficiently large that we believe it is necessary to work with a large dataset, such as we have, to get an accurate picture of system usage. In this dataset, any random sample from one library or one quarter, much less from one terminal, would not be an accurate representation of user behavior.

While we did not dwell on error behavior in this report, we did find that an average of 13.3% of all commands are either typographical or logical errors, and 12.2% of all sessions consist entirely of errors. However, most of the all-error sessions are very short. We do not know if these error rates are high or low, as we have nothing with which to compare them. Error behavior will be explored further in a future report.

The monitoring study of the Library Control System resulted in far more data than are presented here. We expect to follow this report with several other papers discussing in more detail such aspects as temporal patterns, error patterns, command sequences, search success, and variance by campus library and academic quarter. We will also compare the data from LCS with that of other online catalogs collected in conjunction with the Online Public Access Project (Tolle 1983). In addition, we hope to compare these data with users' self-evaluation of searching behavior and satisfaction with LCS as reported in the user survey portion of the Online Public Access Project (Markey 1983).

Because the Library Control System is under continual development, we also hope to gather more data at a later date. By comparing datasets from two points in time, we may identify the effects of system enhancements on user behavior.

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